

CIRCULAR ENTERORRHAPHY BY A NEW METHOD.

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INTESTINAL operations until recently were recognized as quite fatal and the ultimate results of such surgical procedures as rather unsatisfactory. But it must not be concluded that the bowel operation of the present day is totally relieved of all its fatality, and its unsatisfactory results. Yet we can say that the strife of surgeons and the competition of experimenters have resulted in hitherto unknown progress in the field of intestinal repair. The results of operations on the alimentary canal depend, probably, more on the individual skill of the surgeon and the condition of the parts than do those in any other field of surgical work.

Hence arise such varying reports and such elastic remarks in this department of surgery. The relative newness of the work, the difficulty in forming an accurate diagnosis and the impossibility of applying distinctly formulated rules to concrete cases lend additional confusion. To this may be added the fact that but relatively few trained surgeons are doing much work in the matter and hence real practical knowledge in diagnosis and technique is not very generally distributed. From such views it is easy to conclude that individual skill and dexterity in operations on the bowels must be acquired by other means than books and occasional cases seen in practice. Under ordinary circumstances then there is but one way to acquire personal, dextrous skill in operations and personal power in diagnosis of intestinal diseases and that is by experimentation on animals and the human cadaver. Even

watching the skilled hands of the masters will not alone suffice. Personal practice and responsibility are the elements that develop the intestinal surgeon. In this article we will speak of one of the operations on the bowel which largely engrossed the attention of all past surgeons who devoted any thought to the subject. It is known as *Circular Enterorrhaphy*, which suggests the reunion of the circumference of a divided intestine. For thousands of years men have been attempting to use what is termed a technique or method to restore the alimentary canal and faecal circulation to a normal condition. Amusing and queer things were done in days gone by in order to accomplish the feat of reuniting an intestine. The 12th century sees the London surgeons and the Paris masters introducing "elder pypes in the guttes under the seme, that the seme rotte not." History records the use of cylinders of dried intestine, bone, wax and tallow to aid in uniting the bowel. Ferrules of metal and the dried tracheas of animals were also employed. All these objects were expected to be absorbed or passed by stool after the gut wound was healed. Now, we practiced circular enterorrhaphy in all the forms known to the books, our experimental operation on dogs and cadavers cover three years and over 200 operations. The time, the number of experiments and particularly the autopsies which we performed ourselves gave us many opportunities to see defects and to study for improvements. The faults, defects and imperfections were what first arose in circular enterorrhaphy. A great many trials were made in various ways to observe the final effects of circular reunion of the divided bowel ends in dogs. After the trials are all over I am more than ever convinced that an innate sense of justice and proper respect for our fellow man should prohibit any surgeon from attempting to do the operation for the first time on a human being. The sources of danger in circular enterorrhaphy are still real and formidable and are at present being met by substituting the rising operation of intestinal anastomosis for it. A statement of some of the dangers which arose in our work may be of interest to the surgeons of this field.

a. Circular enterorrhaphy paralyzes totally or partially, for a variable time, the segment of the operated bowel. The paraly-

sis thus checks peristalsis and the immediate object of the operation, which is to overcome obstruction, is lost. The fæcal circulation may not be aided and relief is delayed. While relief is being delayed, fæces, fluids and gas are accumulating above the point of occlusion, and also increasing peristaltic violence above the obstruction may endanger the rupture of the newly made stitches by persistent pressure at the seat of operation.

b. The lumen of each gut may be of different size and hence difficult to safely unite. The lumen of the large gut could be narrowed by puckering or a V-shaped excision, but every pucker and wound adds danger to the procedure.

c. It may be followed by stricture. As a matter of fact it was many times followed by stricture, which narrowed the gut lumen one-fifth to one-third or one-half of its original size. In some cases I found that the stricture was even obstructing the passages of gas or fluid or fæces by the gut narrowing and kinking on itself. The actual lumen of the stricture was about the size of a crow's quill. These occurred in autopsies from 1 to 3 weeks after the operation. Would the strictures progress to contraction or dilatation of their lumen?

d. Fæcal fistula is apt to occur at the seat of operation from gangrene of the gut tissue due to the pressure of numerous sutures. Fæcal fistula is one of the essential objects to overcome in any intestinal operation.

e. The gut is in a pathological condition due to injuries from violent peristalsis and obstruction. The bowel having impaired physiological functions—especially circulation and nutrition—does not readily unite. The constant pressure of gas, fluid and fæces against the wall of the bowel will stretch its tissues so that their vitality of repair is lost. The power to retract to the normal condition has ceased, because excessive and long-continued pressure has paralyzed the nerve supply.

In some dogs we found in the autopsies knuckles of fæces actually projecting through the gut wall, and these were in dogs which we had killed to obtain specimens, and which appeared fairly healthy after such operations. It would, no doubt conduce to safer recovery if a considerable piece of path-

ological bowel was entirely cut away by resection—until healthy gut was met.

f. One of the essential factors in circular enterorrhaphy is the time required to perform the operation. If one uses from 20 to 40 Czerny-Lembert sutures, it will consume at least 45 to 60 minutes. We considered in our experiments that the exposure of a dog's intestines for 45 minutes was sufficient, occasionally, to kill him. Hence, if 45 minutes' exposure was enough to shock some dogs to death, varying durations of exposure would have corresponding effect on final results. The shock in the case is due to low temperature and manipulations, *e. g.*, several times I have stopped a dog's breathing by intentionally dragging on his stomach.

g. We found that after the operation kinking of the gut frequently occurred at the seat of action, it was mainly due to the adhesions formed at the point of operation—and also that the peristaltic bowel motion was kept up on each side.

h. Another source of danger that occurred quite a number of times in the operation was the invagination of the proximal bowel into the distal bowel at the seat of operation. This invagination not only occurred but killed several dogs, so that it must be named as a real source of danger.

Some of the above reasons induced me to cultivate other methods in performing the operation. I cultivated two new methods but will only speak of one in this article. The idea in this new operation is to gain good immediate, and remote results—no stricture or tæcal fistula. I have never read or heard of the operation being done.

The old idea of old intestinal surgeons was that to secure perfect healing of bowels, serosa should be approximated against serosa. Now I found by actual experience that serosa against serosa will not always heal, and not only that, but even if serosa is applied against abraded serosa the healing is not universally perfect. The surest healing is acquired by applying abraded or scarified serosa against scarified serosa, and retaining it in a fixed position; scarified peritoneum approximated against scarified peritoneum and fixed in position so as to render physiological and mechanical rest efficient, gives the surest and most perfect healing. Now, I applied this law still

further to the fact, known through all ages, that scarified or abraded surfaces, if coapted or fixed in coaptation, will heal universally. Hence it matters not whether it be mucous membrane applied against serous membrane, or mucous membrane applied against any other membrane; so long as both membranes were well scarified, healing would result. With this law in view I began experimenting with the healing of scarified mucous membrane to scarified serous membrane. Of course it healed like the two surfaces of a cut wound. In dealing with the mucous membrane of the intestines one must not forget that he has to do with glands—a secreting surface. My first mistake was that I did not properly destroy these glands. The follicles of Lieberkuhn and the tubular glands or other secreting apparatus extended much deeper into the gut wall than I, at first, supposed, and hence I lost some dogs by not cutting the mucous membrane well away.

In this operation, like Jobert's operation, one must definitely determine the direction of the bowel, the surgeon must positively know the direction of the fæcal circulation. The standard to go by is, first and above all, the cæcum, and second, the sigmoid, and third, the duodenum. I tried Prof. Nothnagle's test which, he claims, distinctly shows by certain contractions the upward or downward direction of the gut. Prof. Nothnagle claims to have discovered, while studying the gastro-intestinal canal, that when he applied against the gut wall a potassium salt, circular constriction occurred. The circular muscular fibres on the gut wall contracted very much more in proportion than the longitudinal muscular fibres. He also claims that when the bowel wall is brought in contact with a sodium salt that ascending peristalsis took place. We carefully repeated these experiments, and the results were so unsatisfactory that we never could tell, by the test, which was up and which was down. Both sodium and potassium salts produced vigorous muscular contraction, and we were, time and time again, positively able to demonstrate vigorous and violent circular muscular contractions from both salts. But the doubtful section of the experiment arose in the part called ascending peristalsis. Prof. Senn claims that he corroborated

these tests in 15 out of 16 cases. More time and light to use the test may give different results.

However, it is an odd peculiarity that the longitudinal and circular muscular gut layers each have a particular affinity for a different salt. If the test could be applied with reliable results in concrete cases, it would be an invaluable aid in much intestinal work. In the second operation I did after Jobert's method, I made a mistake in the gut's direction, which cost the dog's life. In one of the operations on dogs while performing the operation of this article, I forgot and invaginated the bowel the wrong way, which killed the dog, so it may be observed how important it is to positively determine beyond a doubt the direction of the faecal circulation. The following experiments, with self-explaining remarks, will make the operation and results demonstrate the utility of the procedure.

Experiment 242.—Dog, weight, 23 lbs. This was a dog on which we had performed anastomosis for intestinal wounds with the segmented rubber plate, 28 days previous. He had three bowel perforations made by a .32 calibre ball. It was also the first time we had performed the operation. The animal was chloroformed, belly shaved and loop of intestine drawn out of a three-inch median abdominal incision. The direction of the bowel was determined from the caecum as a standard. After completely severing the bowel a rubber tube three inches long, and one fourth inch in diameter was stitched into the proximal gut, and an inch of the serous surface of this gut was scarified. The mucous membrane of the distal bowel end was dissected off one-half inch with curved scissors, and then the same freshened surface was well curetted so that all the intestinal glands would be destroyed. Now, the proximal bowel end was pushed into the distal bowel lumen, as one joint of stove-pipe is pushed into another. The distal bowel was drawn over the proximal and sutured in position. A graft of omentum was carefully folded around the operated parts and fixed by sutures. The sutures which fixed the two gut walls together passed entirely through the circumferal margin of the distal bowel and also through the peritoneum and muscular layer of the wall of the proximal gut, avoiding the penetration of its mucous membrane. The dog died on the third or fourth day. The second operation revealed the existence of a chronic peritonitis—a progressive fibro-purulent peritonitis of a most typical form. Nature had made brave efforts to

encapsulate pus and infection, and no doubt would have succeeded but for the second operation, which induced general peritonitis. The circular enterorrhaphy was healing nicely. The graft had contracted firm and strong adhesions. The rubber tube kept the fæcal channel open, and also held in constant approximation the two gut walls while healing. Three points were noticed in the proximal gut at the seat of operation which showed that the needle had penetrated too deeply but were healed. As the parts of the intestines operated on were progressively healing, it may be considered that the dog's death was due to lighting up anew the peritoneal infection. Dogs do not resist infection well in second or third abdominal sections, especially when done close to one another as regards time. No doubt had this been the first section the dog would have lived. The essentials of the operation are cleanliness, the long rubber tube to keep the fæcal channel patent and the gut walls in contact, and to prevent eversion or rolling out of the gut ends. The mucous membrane must be thoroughly dissected away and a large omental graft must be well applied and sutured in position.

Experiment 243.—Dog, female, weight 75 lbs. The usual preparations were made, and out of a median abdominal incision a loop of intestine was drawn. The first thing to do in this operation after the abdomen is opened, is to determine the direction of the intestinal canal or the fæcal circulation. I always took the cæcum as the standard by which to decide. The sigmoid and the duodenum were often valuable, but not to be compared with the cæcum.

After the gut's direction had been determined, it was severed. The serous surface of the proximal gut end was scarified for an inch, and a rubber tube, one-half inch in diameter and four inches long, was stitched into it. The mucous membrane of the end of the distal bowel was dissected off with curved scissors for three-fourths of an inch. The proximal bowel was then inserted into the distal gut lumen in the same manner as one joint of stove-pipe is joined to another. The circumference of the distal bowel wall was sutured to the serous or peritoneal surface of the proximal gut by an interrupted suture. An omental graft was snugly wrapped around the operated parts and sutured in position. The abdomen was closed by four stitches to inch, linen, including the skin fascia, conjoined tendon of the abdominal oblique muscles (the three), and peritoneum. The dog made an uninterrupted recovery, and twenty-four hours after the operation ate and drank. She began to play after three days.

Twenty-three days after I sacrificed her for other purposes.

The autopsy was very instructive and suggestive. The abdominal organs were all healthy in color and all other ways, except an enterolith about the size of a man's fist. The enterolith consisted of hay, straw, and hair, which she had bit from her own body. It was very difficult to know why it lodged just above the operated parts, as the gut was scarcely narrowed. It was not contracted a particle more than the width of the bowel wall. However, no doubt the newly wounded gut had not yet recovered its normal dilatibility and contractility—elasticity. It would also be hindered in its movements by the graft which had formed firm and strong adhesions on the entire circumference of the gut wall. The adhesions were of the nature indicating the formation of new tissue from cell proliferation—new connective tissue and blood vessels with, no doubt, nerves and lymphatics. I think the enterolith would have dissolved away as the fluids trickled through it. A peculiarity in the case is that the dog showed no signs of being encumbered with an enterolith or any obstruction. In fact, she played, ate and drank until the end. In testing the capacity of the normal gut and the part operated on scarcely any difference could be detected in size, hence the cause of the enterolith was no doubt due to the difference in the function of the operated and non-operated parts. The anatomical difference was insufficient to account for it. It appeared to me as a suggestive sample of Littre's hernia or the partial paralysis of any gut after circular enterorrhaphy. Its peristalsis was partially destroyed, and hence was a menacing point in the faecal circulation endangering intestinal obstruction at any moment from sheer mechanical accidents, due more to physiological defects than in sufficiency of anatomical structure.

Experiment 250.—Dog, female, weight, 8 lbs. Animal chloroformed, belly shaved, and a three-inch median incision made. A loop of ileum was drawn out and divided. A one-fourth inch rubber tube, three and one-half inches long, was stitched into the proximal end of the gut by a single stitch of linen thread. The longer part of the tube projected above the divided gut end. The distal bowel end was then seized and the mucous membrane was clipped off for one-half to three-fourths of an inch by means of a curved scissors. To be sure the mucous membrane was destroyed it was well raked over with a fine-toothed forceps. The proximal gut was then seized and the serous membrane on its end for about an inch was well scarified. Now the proximal end, containing the rubber tube, was inserted into the distal end, and the edge of the circumference of the distal gut was sutured against the serous membrane of the proximal gut by a partly continu-

ous and partly interrupted suture. A graft was well wrapped around the operated parts, and sutured in position. Abdomen closed by sutures, linen, four to inch, passing through skin, fascia, theca or abdominal tendon formed by the blending of the oblique muscles. The dog recovered quite well, was moderately sick for two days, and then ate and drank continuously, and even played.

I shot the dog thirteen days after. The autopsy revealed perfect healing, few adhesions and a firm and solid graft which hermetically sealed the operated parts. By a careful observation the gut lumen appeared to be narrowed about one-seventh of its original. This would never have disturbed the future economy of the dog under natural or ordinary circumstances. The result of this circular enterorrhaphy was about as perfect as I had ever seen among a large number.

Experiment 251.—Dog, male, weight, 15 lbs. Animal chloroformed, belly shaved, and a four inch median incision made. A loop of small intestine was pulled out and severed. A rubber tube, three-eighths of an inch in diameter and three inches long, was sutured in the proximal end of the bowel by passing a suture through the gut at its incised margin and through the rubber tube wall. The distal gut end was secured, and the mucous membrane was well clipped away with curved shears for about one-half inch. The proximal gut was well scarified on its mucous surface for an inch from its cut end by a needle point. The proximal bowel with its tube (rubber) was then inserted or invaginated into the end of the distal bowel. The distal bowel circumference was then sutured to the serous surface by a continuous suture, four to the inch. An unsevered graft from the side of the great omentum was wrapped around the operated parts and sutured in position. Occasionally the serous surface over the operated parts was scarified, as well as the applied surface of the omental graft. The dog was sacrificed ten days after for the purpose of securing the specimen. The graft had formed firm and thick adhesions, completely sealing up the operation. The gut had well healed. The sutures had not yet dropped into the gut lumen. This taught me that interrupted sutures are safer than continuous. The general adhesions of this operation were mainly few in number. The tube was gone, and it generally disappeared between the second and fifth day. One of the essentials to success in circular enterorrhaphy is the use of this tube, which I learned to use from experimentation. It keeps the bowel lumen patent and aids in preventing invagination, which often follows the operation. The dog made a prompt recovery. He drank, ate and played from the third day after the operation.

Experiment 254—Dog, female, weight, 11 lbs. The usual preparations being made, a loop of intestine was drawn out of a median incision and divided. This dog was sick at the time of operation. His intestine was so œdematous as to be between two and three times its normal thickness. It was succulent, swollen and infiltrated. The proximal gut was scarified on its serous surface, and a three-inch long rubber tube sutured into it. The mucous membrane was clipped off from the distal gut for one half to three fourths inch. In clipping the mucous membrane away from the distal gut I accidentally cut a hole in the wall of the bowel at the point of denuding the mucous membrane. I thought it would be all right if I sutured this little hole, which was done. The proximal gut, containing the tube or rubber, was invaginated into the distal bowel, and the circumference of the distal bowel was sutured to the serous membrane of the proximal bowel by a partly continuous suture and partly interrupted one. The parts were scarified and an unsevered omental graft applied over the whole, and held in position by fine sutures. I was well rewarded for suturing the little bowel wall perforation instead of cutting off a small piece of the gut and re-denuding the mucous membrane. The dog died in some forty-eight hours from a fecal fistula occurring at the point where I cut the little hole with the scissors. This was a death from carelessness. Such holes should not be sutured, but the whole bowel cut away until the perforation was reached, and then re-denude the mucous membrane thoroughly. In this case the dog's resistance was not normal from disease. It was difficult to suture the bowel at all, as it was friable, brittle and easily torn.

Experiment 197.—Dog, female, weight, 6 lbs. A loop of small intestine was drawn out of a median incision and severed completely. The serous surface on the proximal gut end was scarified and a rubber tube, three inches long, sutured in it. The mucous membrane of the distal bowel was well denuded for one-half inch. The proximal bowel was inserted into the distal bowel lumen, and the circumference of the distal gut sutured to the serous membrane of the proximal gut. A graft was fixed in position covering the whole operated parts. This dog made an uninterrupted recovery, and Dr. Miller took him home as a pet for his boy two weeks after the operation. Some time after this Dr. Miller sacrificed the dog for other purposes. He found in the autopsy some adhesions, the tube gone. The narrowing of the bowel tube was not very marked from such an operation. The graft was well and firmly grown, and is in many cases the sole salvation of life in intestinal operations. At the time of operation this dog was a weak,

scrubby, diseased animal, almost starved, but after the operation, with wholesome food, she gained flesh.

Experiment 195.—Dog, female, young, weight, 10 lbs. Animal chloroformed, belly shaved, and out of a three inch median incision a loop of small gut was drawn and completely divided. The proximal gut was supplied with a rubber tube, one-fourth by three inches, and its serous surface well scarified. The distal gut was well denuded of its mucous membrane for three fourths of an inch by means of a curved scissors. The fæces in each case were forced in each direction away from the point of division of the bowel, and the parts well protected by compresses of cloth. It was also a point in the operation to see to it that only the bowel operated on was either exposed or manipulated; the rest was pushed back into the abdominal cavity. The proximal bowel and its rubber tube was now pushed into the lumen of the distal bowel for about an inch. Then the circumference of the margin of the distal gut was sutured with a continuous Lembert suture to the serous surface of the proximal gut. A large omental graft was well applied and wrapped around the operated parts, and fixed in position by three fine linen sutures. Scarification between the parts operated on and the applied surface of the graft was not always practised, because the operated part of the gut was so much manipulated that it practically equalled a scarification.

This dog made an excellent recovery. From the hour of operation I never saw a bit of difference with this dog from absolute health, for he played just as hard as he could. He ate and drank from the first with a vigorous determination to keep up a long fat future, in which he succeeded, in part.

On the eighth day after the operation I killed him with chloroform because he howled so vigorously as to become a nuisance. Notice that he played actively, ate voraciously and drank naturally until the day of his taking off by chloroform. The autopsy revealed a curious condition. The dog was kept in a large cellar where straw, coal, etc., lay scattered around. I might remark right here that dogs are subject to enteroliths of various sizes and conditions. I have found them frequently in the dog's intestines. They generally consist of hay, straw, tangled strings firmly interwoven, and in the meshes lie solids of various kinds: This little fellow had swallowed two pieces of coal, one $1 \times 1 \times \frac{1}{4}$ inches, and one $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{4}$ inches. The operation had narrowed the gut lumen probably one fourth of its original size, and these two pieces of coal had lodged against it. Hay and straw, etc., had also entwined their threads around them until the enterolith was large and

hard. Fluids and gases passed on as fæcal circulation. Violent peristalsis had progressed for some time for the coal prominences had formed ulcers in the mucous membrane. One ulcer was three-fourths of an inch long, and excavated quite deeply into the tissues. Another ulcer was some one-half inch long and quite deep. It may be noted that I have allowed liberally for contraction when I say that through the operated parts the little finger passed easily. It must not be forgotten that the small intestine of a 10-lb. dog is not much larger normally than a man's little finger.

The graft was perfectly healed, firm and strong, hermetically sealing the whole. The enterolith must have started early, for the peritoneum over the operated gut and for about two inches adjacent was some five times as thick as normal, and the gut was quite congested. The threads were gradually dropping into the gut lumen. The rubber tube was gone. But it had disappeared a little too soon, as the end of the proximal gut had rolled up a little, and caused the previously described stricture. The union of all the wound was absolutely firm and solid. The rolled mucous membrane which projected into the gut lumen had atrophied slightly at its periphery, but would no doubt require a long time to complete the shrinkage. All the abdominal organs appeared healthy, except the congestion at the seat of operation. Every operation convinced me that the rubber tube was one of the essential factors in the operation. Also that the greater part of the tube should project on the proximal side of the point of operation, and that it should be so stitched in the gut as to remain three to six days. The long tube aids in preventing stricture and invagination.

Experiment 246. Dog, female, weight, 25 lbs. After the usual preparations a loop of small intestine was drawn out of a median incision and divided transversely. The proximal gut end was scarified on its serous surface, and a rubber tube four inches long and one-half inch in diameter was stitched in it with a linen thread. Occasionally I put two stitches in the tube to hold it longer in its position, and also it aided in inserting the proximal into the distal gut lumen. The distal bowel was denuded of its mucous membrane, for three-fourths of an inch, by means of the scissors and curette. The proximal gut was then inserted into the distal gut lumen. The circumference of the divided, distal gut end was sutured to the serous membrane of the proximal gut one inch above its divided margin. A graft was then wrapped around the operated parts and fixed in position by sutures. The dog died thirty-six hours after the operation from shock due to hæmorrhage.

This taught me a good lesson. I noticed that the dog had full mammary glands, and that they bled very severely at the operation. But I thought the bleeding would cease after closure of the abdominal cavity. Yet the bleeding persistently continued, and in twelve hours the dog had lost nearly a pint of blood, and I thought surely it would cease after that, but those enlarged mammary arteries continued to flow until the dog was simply exhausted. The dog gaped and yawned until death closely followed the end of the red stream of life. The abdominal cavity appeared healthy. The intestines were quite yellow and very pale. The circular enterorrhaphy was healed almost perfectly. The graft hermetically sealed and excellently closed the operated parts, having firm and solid adhesions. The bicornuate uterus contained the remains of six recently delivered zonular placentæ. The operation in this case must be looked upon as a failure from neglect in checking hæmorrhage, and not failure in the seat of operation, for the condition of the operated parts was excellent at the end of a day and a half—a critical time in any intestinal operation.

Experiment 245—Dog, female, weight 10 lbs. A loop of intestine drawn out and its direction determined. The serous surface of the proximal gut end was scarified an inch, and a tube, one-fourth by two and a half inches, was stitched into it. The mucous membrane of the distal gut was dissected away between one-fourth and one-half inch. The proximal bowel was then inserted into the distal bowel lumen and sutured in position. A graft was carefully applied. The dog died forty-eight hours after the operation from leakage at the point of union of the divided bowel. Cause of death was intestino-peritoneal septicæmia, due to fæcal fistula. The two mistakes which led to death were, first, the mucous membrane was not thoroughly dissected off, and second, the proximal gut was either not invaginated far enough into the distal gut lumen, or it slipped out, and hence caused a fæcal fistula.

Experiment 199.—Dog, male, weight 12 lbs. Operation done as usual, with rubber tube and graft. The dog died forty-five hours after the operation from fæcal fistula at the seat of operation. The parts were not closed with sufficient care.

The above are ten samples of this operation which illustrate its technique, and give some general views of its applicability and utility. The work has taught me that the approach to correct diagnosis and proper treatment of the gastro-intestinal tract in any surgical line requires skill and dexterity, that com-

mon sense and human justice would both dictate should be acquired at the expense of the life of the lower animals, and not of that of our fellows.

Operative course upon the cadaver or watching the masters will neither be sufficient, but to adequately meet these trying emergencies, and to do the work with that kind of skill and judgment which defies the criticism of professional witnesses absolutely demands a certain amount of personal preparation in experimental lines. I have more than once seen the wrong tying of a thread kill a dog. A man is just as easily doomed.

The evils to be avoided in this operation on the intestines are similar to those in any department of gastro-intestinal repair. They are, first, immediate, and, second, remote. The immediate evil results are fæcal fistula, which invites the dreaded peritonitis to end the scene. The remote effects are stricture or such narrowing of the channel of fæcal circulation as to give rise to obstruction. I have many a time and oft demonstrated that an artificial fistula made in intestinal anastomosis will contract and narrow from one-fifth to one-third, and even one half, of its original size by the end of two months. These artificial fistulæ are nearly always endowed with a distinctly sphincter-like condition. The edges or circumference of the sphincter are thickened and act positively elastic. More experiments must be carried out to throw light on what will be the outcome of these fistulæ and strictures. General experience shows that they gradually but progressively contract. The strictures from circular enterorrhaphy in my experiments have acted exactly similar to the artificial fistulæ, but the experiments seemed to demonstrate that stricture from circular enterorrhaphy was more apt to occur, and also more apt to contract into dangerous obstruction. This is, no doubt, due in a measure to the difference of the longitudinal and circular muscular fibres of the gut. The experiments on animals positively show that peritoneal plastic exudates are indefinite as to time and quantity. The exudates may be produced in a few hours, or be delayed more than a day. Hence, a good graft is required, and such plates for anastomoses as will last four to six days, *e. g.*, the segmented rubber or raw hide plates can be made to absorb at will, as regards time.

During considerable time and a large number of experiments, the results were often marred by what is known as invagination. We lost quite a number of animals after operations on the intestines which, if the invagination had not occurred, would not have died. This induced me to study how to avoid the accident. After considerable experimenting I found that rubber tubing was a definite aid in preventing invagination. At first I used rubber tubes from one to two inches long, but they did not entirely prevent the accident, so finally we adopted the experiment of using rubber tubes, three to four, and even six, inches long. We never had any death from the accident of invagination after we used the long rubber tube. But the main portion of the tube should project above the seat of operation on the proximal side. The tube should remain in position for four to six days. I never saw any obstruction either while the tube was in position or after it had become disengaged from its position. Obstruction and operative procedures are generally accompanied by fluid fæces at the seat of disturbance, so that the fluid fæces would easily pass through the tube. The tube should not be too large in diameter, or it may cause gangrene and fistula by its pressure, but it should be thick enough to keep the gut walls patent, and hold in continuous approximation the healing surfaces. The tube I found good in all forms of circular enterorrhaphy, and in Jobert's operation. The threads were absorbed or worked their way gradually into the bowel lumen. If one bowel lumen is considerably larger than another in performing the above operation the larger lumen could be narrowed by V-shaped incisions, but under such circumstances the intestinal anastomosis by segmented rubber plates or raw hide plates is safer.